View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Sydney eScholarship

WORKING PAPER

ITLS-WP-14-01

Development of an online diary for longitudinal travel / activity surveys

By
Stephen Greaves, Adrian B. Ellison, Richard B. Ellison, Christopher Standen, Chris Rissel* and Melanie Crane*

*Sydney School of Public Health, University of Sydney NSW 2006 Australia

January 2014

ISSN 1832-570X

INSTITUTE of TRANSPORT and LOGISTICS STUDIES

The Australian Key Centre in Transport and Logistics Management

The University of Sydney

Established under the Australian Research Council's Key Centre Program.

NUMBER: Working Paper ITLS-WP-14-01

TITLE: **Development of an online diary for longitudinal travel / activity surveys**

ABSTRACT: Motivated by the continued search for methods to reduce participant burden and non-response, and improve the quality of travel data, this paper details the development of a new online travel/activity diary to support a major longitudinal investigation of travel in Sydney, Australia. The diary employs several innovative features designed to simplify the process of data entry, and improve participant recall and completeness of travel, including auto-fills, prompts, trip editing capabilities, favourite trips and a drag-and-drop technique for capturing travel mode. An additional innovation is the ability to view a GPS-based Google map of daily travel while completing the diary to assist with recall. The diary is tested on 37 participants, with a range of diagnostics provided to assess their comprehension and interaction with the diary, reaction and burden, and completeness of data provided. Overall, 89% of participants complete all seven days of the diary with 75% indicating no issues once they become accustomed to how it works. Trip entry times average around two minutes/trip with three-quarters of trips entered within 24 hours of being made and 96% of trips provided with complete details. In terms of the GPS component, while the data itself is of variable quality and the optional viewing of trips is lower than anticipated, those carrying a GPS report more trips/day and segments/day, fewer missing days, and provide more complete trip data.

KEY WORDS: ***Travel surveys; online travel diary; GPS***

AUTHORS: **Greaves, Ellison, Ellison, Standen, Rissel and Crane**

CONTACT:

INSTITUTE of TRANSPORT and LOGISTICS STUDIES (C13)
The Australian Key Centre in Transport and Logistics Management

The University of Sydney NSW 2006 Australia

Telephone: +612 9114 1824
Facsimile: +612 9114 1722
E-mail: business.itlsinfo@sydney.edu.au
Internet: http://sydney.edu.au/business/itls

DATE: January 2014

1. Introduction

The limitations of paper-based diaries and telephone surveys as a means of reliably recording travel are well documented in the transport survey literature *(1)*. In response, a variety of technological innovations have been pursued to encourage participation, improve the quality of data collected and simplify the survey task, while trying to keep costs down. One such innovation is the online travel/activity diary, the rationale for which is provided on the one hand through web-based capabilities to improve/enhance the survey experience, and on the other through access to participants via the explosion in Internet access and use in contemporary society – in 2012, 82.3% of Australians accessed the Internet using a fixed or mobile access point (http://www.itu.int). Despite this, online travel/activity diaries have (arguably) not yet fully exploited the full potential of web-based capabilities, focusing instead on replicating the process by which paper-based diaries are completed. In addition, while information on response and completion rates is generally provided, little is known about participant reaction to and experiences with online surveys.

The current paper details the development of an online one-week travel/activity diary, designed to support a major investigation of travel in inner-city Sydney, Australia. Briefly, the aim of the study is to investigate changes in travel behaviour following the construction of a major piece of bicycle infrastructure in the area. Of particular interest are changes in cycling and walking including access/egress travel to other modes of transport, typically public transport. The online diary incorporates several unique features, designed to simplify the process of data entry and improve participant recall. An additional innovation is the ability for participants to view a GPS-based Google map of their travel while they complete each day of the diary to assist them with recall. The study itself comprises three waves of data collection, meaning that in addition to being something completed in the present, the diary becomes something that participants would be willing to do again. Following details of the development of the diary tool, the approach is tested on 37 pilot study participants, gauging both their usage of and reaction to the diary before drawing conclusions about the merits of the approach.

2. Literature review

Travel diaries are a well established method for collecting information on travel patterns of individuals and households. The data collected from travel diaries are used extensively for transport planning *(2, 3)* and other more specific studies of travel behaviour *(4)*. A key feature of travel diaries that have contributed to their extensive use is the potential to collect additional information about an individual's travel over and above simply origin, destination, mode and time. This includes information ranging from the availability and cost of parking at a destination *(5)*, additional information about the destination and purpose *(6)*, information on the vehicle being used, and (if a car), the number of passengers *(7)*. Kenyon *(10)* suggests that diaries (online and paper based) should be designed with four objectives in mind. Namely, the diary should take no more than 20 minutes per day to complete, a figure which is arguably too high once the diary period stretches beyond a day or so; be intuitive; have a shallow learning curve; and prompt participants for the required information at every stage of the diary.

Internet surveys have now been used by transport researchers for more than a decade *(8, 9)* and have increasingly replaced paper-based travel diaries. However, they have largely replicated the format of paper-based travel diaries *(10)*. One recent example is provided by Theriault et al. *(11)* in which a web-based version of a paper diary was used to study travel behaviour of car share users in Quebec over seven days. The survey employed many innovations including an online mapping tool, but the number of fields on one page (96 in total) may have proved over-whelming, with 37% of participants completing all seven days. This suggests that issues affecting self-reporting of travel may also apply to online travel diaries in the same way as for the (similarly structured) paper diaries. These include high rates of non-completion due to high respondent burden; the potential for questions to be interpreted differently by different

respondents; and skewing of samples towards more literate sections of the population *(12)*. An additional issue is that, in the case of multi-day travel diaries, respondents have been known to wait until the end of the diary period to complete it. This can result in activities and trip details being forgotten, or telescoped to the wrong day *(13)*.

Taking advantage of some of the additional capabilities of a web interface provides opportunities to address some of these issues. These improvements may include a well designed, user-friendly and attractive user interface that have been found to both engage participants and reduce respondent burden, which are important for maximising response rates *(14)*. In a recent example, Bourbonnais & Moreney *(15)* describe a web-based household travel diary developed as a potential alternative to the established CATI household travel survey in the Quebec region. Designed as an activity-based diary, the diary adopts an interactive approach to guide respondents through each activity and includes an online map to help respondents find addresses. An initial survey using this diary had 60% of participants completing the diary. Further improvements to a standard travel diary have been made by Ali and Lui *(16)*, who used GIS data and word recognition software to allow respondents to enter locations by entering the beginning of the name of a location or intersection and then selecting the location from a list of matches. The same study also provided respondents with the ability to correct data which had been collected during the recruitment phase.

Of particular interest given the objectives of the current study is how to improve the reporting of short walking and cycling trips, either on their own (such as to the corner shop or local library), as access to or egress from public transport, or as part of multi-modal trips more broadly. These trips have generally been reported inadequately, if not excluded entirely, from many travel diary surveys *(17)*, an issue that could potentially be substantially improved by taking advantage of some of the benefits of online diaries. One option is to mimic the prompts used in some telephone interviews, where participants are asked further questions if certain types of trips (or absence of trips) are reported. A study on university students in Virginia prompted respondents to both confirm and explain why they had made only one trip during a day *(18)*. Other additions included a separate question on the total number of trips made that could then be checked against the trips reported. A study conducted in 2010 with a specific focus on active travel included both activities and trips in an attempt to improve reporting of access and egress travel *(19)*.

Another, sometimes overlooked, benefit of online travel diaries is the ability to keep a detailed track of completion rates while the study is in progress. This opens the possibility for targeted reminders of respondents who did not complete the diary on a particular day *(16, 20)*. Although potentially problematic for long-duration travel studies, email reminders can be sent periodically to remind respondents to complete the diary, potentially reducing non-response rates in a manner that is less intrusive than repeated telephone calls.

Taking this a step further, there is the potential to incorporate the capabilities of automated data collection tools in an online survey to assist participants in recalling their travel. To date, this type of 'prompting' has largely been associated with Global Positioning System (GPS) data, which after being processed into trips are then played back to participants, who then provide additional information such as mode, purpose etc *(20)*. A crucial issue here is the timeliness with which data can be processed and played back, particularly when data are being collected over a long period of time, as participants may get confused recalling between days *(21)*. While this is relatively manageable for car-based travel, the processing challenges increase substantially for person-based GPS travel. This is due to the practical issues associated with relying on people to keep the devices charged and with them, and the higher rates of spurious data making trip identification more challenging *(13)*.

3. Travel Survey Design

3.1 The online diary

The principle requirements of the online travel diary were that it needed to be intuitive for participants to use, quick to complete, and importantly, also capture participants' incidental walking and cycling activity. Following several development iterations, the final travel diary was developed and worked as follows. Upon entering the diary for the first time, participants were required to provide home and work (if applicable) details including address information. They were then asked to complete the diary for the previous day with the option of completing up to the current day/time if desired. On each day, participants were asked which activity they participated in *first*. On subsequent trips, they were asked which activity they participated in *next*. Subsequently, participants entered basic details (departure time, arrival time, origin and destination) for the trip. Participants were then asked to drag and drop the modes of transport which they used in the order in which they used them (*Figure 1*). If a mode required access or egress and it was the first or last mode in the trip, the participant was given a prompt, e.g., "How did you get to the bus?" This ensured that incidental walking and cycling were captured in addition to the trip's main mode. Additional information was collected for bus, train and light rail segments. Lastly, participants were shown a summary of the trip and were prompted to record anywhere else they had travelled that day. After all the trips for a particular day had been completed, a summary of all the trips was shown and participants were asked to confirm that details were correct before being taken to the next day of the diary. Data were saved to the database at the completion of every step and re-entering the diary at any time would return the participant to where they left off.

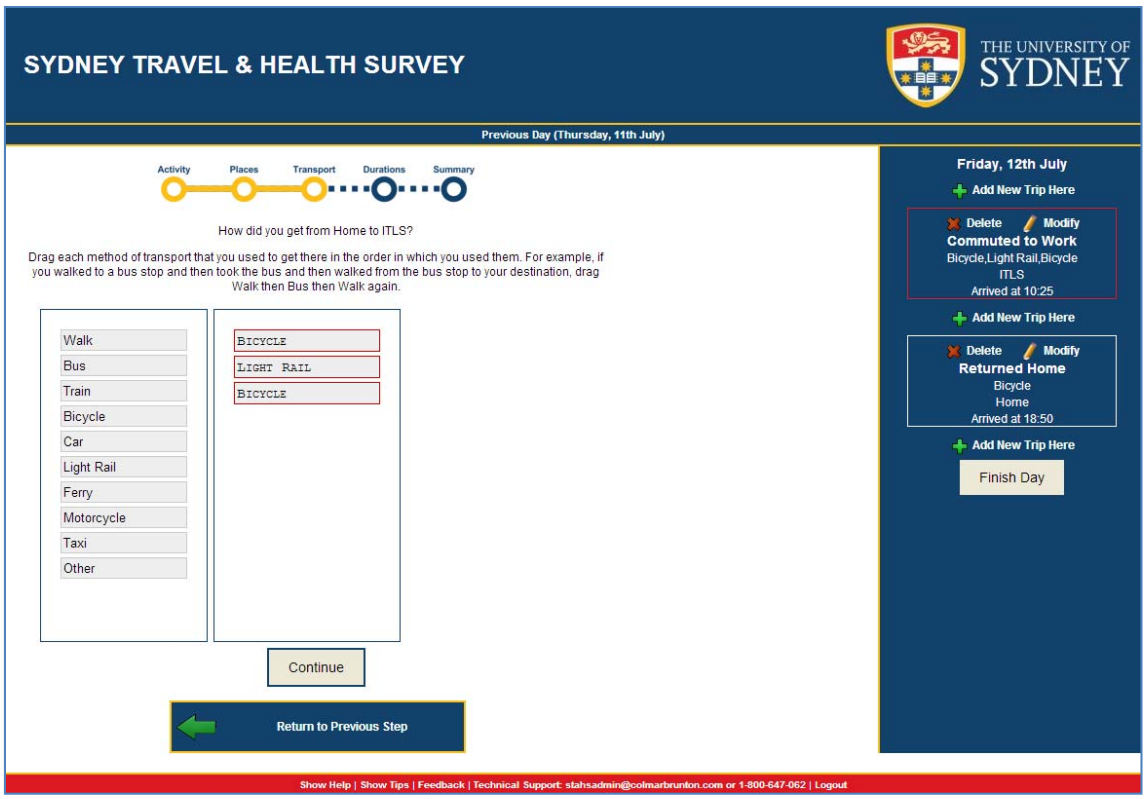


Figure 1: Drag and drop interface

The diary contained a number of key features designed to reduce participant burden and improve the quality of the data collected. To aid in answering potential questions from participants, tips and a page-specific help section could be accessed on every page of the diary. Many fields included auto completion functionality. This allowed participants to type in part of

the origin and destination place names which brought up the most relevant known places. These included shopping centres, schools and train stations (among others) in the study area as well as the origins and destinations of places they had previously entered. Previously used places were always shown first. A summary of the day's trips were shown on the right hand side of every page (Figure 2) enabling participants to see, at a glance, the information they had already entered and – if necessary – modify, delete or add trips. Furthermore, the diary was designed to pre-fill fields where the answer was already known or highly likely to be known. For example, a trip's origin was automatically set to the destination of the previous trip and the departure time was automatically set to the arrival time of the previous trip. Similarly, if the trip activity was 'returned home', the home location was pre-set as the destination. At the completion of a day, if the last trip did not end at home, participants were prompted to confirm that this was correct. To further reduce participant burden, trips could be saved as *favourites* and used as the basis for later trips. In these cases, all the fields – except for the arrival and departure times – were automatically filled in, leaving participants only needing to confirm that the information was correct before continuing. Lastly, for participants that elected to carry a GPS device, a Google map showing recorded travel for the day could be displayed or hidden by clicking on a navigation link at the top of the page.

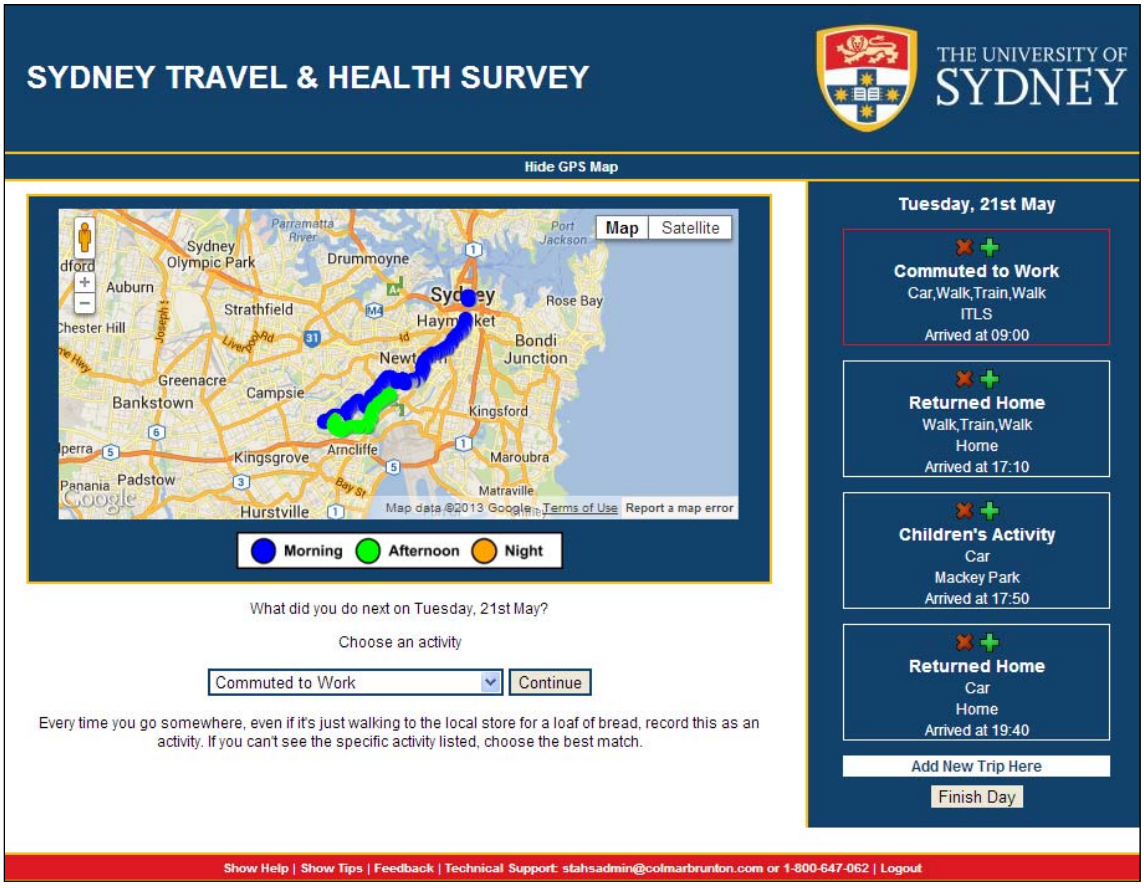


Figure 2: Online travel diary

3.2 Reminders

An important component of the study was the use of email reminders to ensure participants started the online travel diary and then completed all seven days. Participants were sent the first email on the Friday preceding the start of the diary period to advise them that the data collection period would start on Monday. On the Tuesday they were sent an email asking them to complete their travel diary for the previous day with a direct hyperlink to their personal diary. The same email was re-sent every day for a week until they started using the diary (i.e., they were given a week to start using the diary). Once they had started using the diary, reminder

emails were sent on days where they had not completed the diary for the previous day, until they had completed all seven days. The aim was to send all email reminders at the same time each day, between 11 a.m. and noon. The main rationale for the timing was that it gave people time in the morning to complete the diary for the previous day (thus avoiding a reminder) and provided time to generate a list of recipients that could be sent out early enough for people to complete their diary before they forgot. A further rationale was evidence to suggest that people are more likely to respond to emails in the morning *(22)*.

3.3 The GPS component

The GPS component of the survey served two primary purposes. First, as a means to assist participants with their recall of travel (see Figure 2) and second, as a means of verifying/correcting data collected by the diary *(17)*. Further, it was conjectured that carrying the GPS device would increase the diligence with which participants completed the diary *(13)*.

In the week prior to data collection, participants who elected for the GPS component in addition to the online travel diary were couriered a small personal GPS device, a wall charger, a USB cable, an instruction sheet and a prepaid return-addressed post satchel. The GPS devices are designed to be attached to key rings to encourage participants take them whenever they go out and have a battery life of around three days depending on usage. Participants were asked to charge them every day using the wall charger or by connecting to a computer using the USB cable. Participants were instructed to switch on their GPS devices two days before the data collection period started, and to take them with them wherever they went from then on. Once a participant had completed all seven days of the online travel diary, they were sent an email instructing them to return the device and accessories using the prepaid post satchel.

To view their travel on a Google map window embedded within the diary (Figure 2), participants first had to download and install an upload utility on their computer (Windows OS only). Subsequently, by connecting their GPS device to their computer using the USB cable, the utility would automatically download all new data from their device and upload it to the University of Sydney's secure server where some initial processing would be completed. Participants could view a map of their travel as collected by the GPS device when completing the diary. If participants chose not to install the software they were unable to see their GPS data since the data was then only retrieved when the device was returned.

3.4 Survey management

Working in an online environment also provides the capability of an efficient survey management system. Building on previous experiences, the interface shown in Figure 3 was developed, which was only accessible to the University of Sydney research team and enabled them to do the following:

- Check the general status of each participant including last time they accessed the travel diary or any GPS data were uploaded.
- View trips and associated GPS data up to the point at which participants had entered their data.

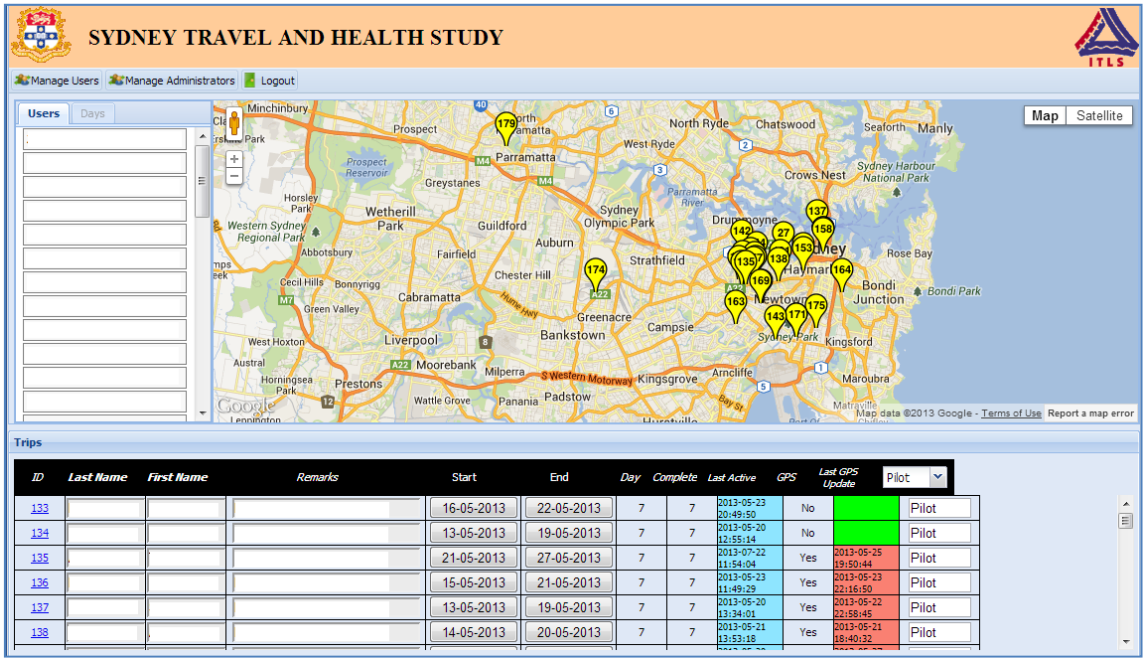


Figure 3: Administration interface

4. Testing of the configuration

4.1 Survey recruitment

Following internal testing of the set-up, 37 participants were recruited from an inner-city suburb in Sydney adjacent to the area for the main survey, to pilot test all components of the survey. The recruitment period ran in two batches of participants during May, 2013. Participants were recruited from an online panel augmented with a computer-assisted telephone interview (CATI) boost-panel to test feasibility of the dual approach. Such panels have become an increasingly prevalent method for securing survey participants [in Australia] given the rising cost and non-response rates associated with telephone surveys and the ability to sample based on demographic quotas such as age and gender *(13, 23)*. Recruits were invited to complete one of two options following an online general health/travel questionnaire. Option A involved completing the online travel/activity diary and taking the GPS device (AU$50 incentive), while Option B involved completing the online travel/activity diary alone (AU$25 incentive).

4.2 Participant reaction and burden

Of the 37 recruits, 30 elected for Option A (diary plus GPS), while 7 elected for Option B (diary-only). 33 participants completed all seven days of the diary, a completion rate of 89%. The remaining four participants, all from Batch 1, did not start the diary at all and, while efforts were made to contact these people to ascertain why they dropped out, this proved unsuccessful. Reaction to the diary was assessed through various mechanisms including email and telephone enquiries during the survey, exit surveys and usage statistics obtained by querying the survey data itself, another advantage of online surveys. In terms of enquiries during the survey, 26 were received, an average of less than one per participant. Of these seven were to do with the travel diary, primarily around access problems and questions about how to complete, while 12 were to do with the GPS concerning device-specific issues and problems viewing trips.

Exit surveys confirmed that overall most participants had enjoyed the survey with only 10% indicating they would not want to do the survey again in 12 months' time. In terms of the diary, 75% of participants indicated they generally had no issues once they became accustomed to how it worked. The negative reaction generally focused around functionality issues, such as browser type/version and speed and the device used to access the diary. Usage information showed that

PCs were used to input 65% of trips, Macintosh (21%), iPads (7%), iPhone (5%), and Android (1%), with some participants using more than one type of device during the survey period. The issue this raised was that, while the diary had been developed in a PC environment [and tested on a Macintosh], it also needed to be made tablet and smartphone friendly, something that has been done for the full-scale deployment of the diary.

In terms of the 30 participants who took a GPS, five recorded no data, suggesting they had not taken the device with them and/or kept it charged, five recorded spurious/incomprehensible data, suggesting device malfunction, while one device was misplaced/stolen during the week of data collection. In addition, signal quality problems associated with using GPS in what was a heavily built-up area, contributed to data of variable quality from many of the remaining devices. This left a total of 19 participants who had complete diary information and GPS information. Ten participants installed the upload utility and plugged the GPS device in at least once, with an average viewing rate of around four times over the one week period – again, it must be reiterated that the utility was only Windows OS-compatible, so around half the sample who could have used it did so. Reaction to the GPS component itself largely corroborated the empirical data, with those providing complete data reporting few problems, and those with no data reporting the usual issues of remembering to keep it charged and take it with them. However, reaction to the trip viewing option was mixed, with initial curiosity giving way to a lack of perceived value in using this as the survey proceeded. Of additional interest in this study was gauging participant usage of the survey, specifically when they accessed the diary, how long it took to complete, and the time-lag between when trips were made and when they were recorded in the diary. In terms of access time, one of the appeals of an online survey is that people are able to complete the survey at a time that is convenient to them. Session start times (Figure 4) showed a peak of activity was realised around noon – the reason for this was the timing of the daily reminders (11 a.m.-12 p.m.), highlighting their importance in facilitating completion of the diary. Interestingly, sessions were relatively sustained throughout the afternoon and evening with a further 'peak' of activity around 10 p.m. This pattern contrasts somewhat with that of a previous study completed by the project team in which active sessions peaked more around 9 a.m. *(21)*. In this case, however, reminders were sent early in the morning, again reiterating the relevance of daily reminders for completing (online) longitudinal surveys.

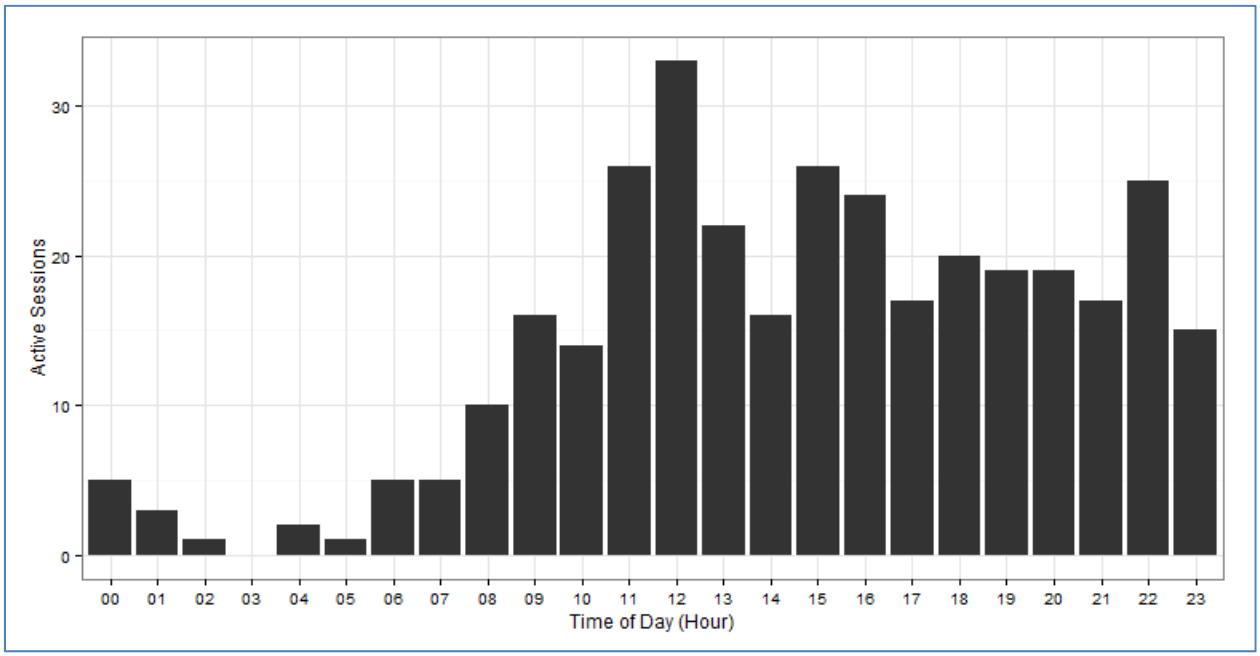
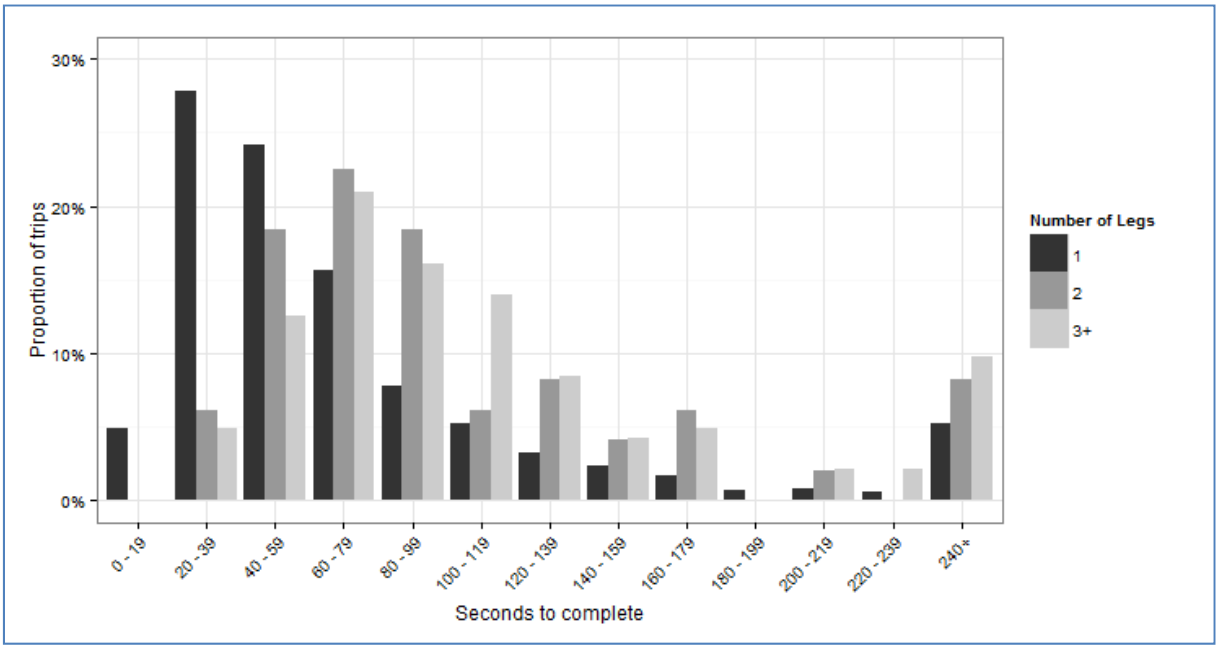


Figure 4: Session start times for completing the online travel diary

Completion times are a useful metric, both in assessing burden and how diligently participants are taking the survey. It might also be anticipated that completion times would improve over time as participants become more familiar with the diary and/or start using the *favourite trip* functionality. Figure 5 shows the time taken to complete the online diary per trip broken down by the number of trip segments. Evidently, the majority of trips were completed in less than two minutes, implying that on average, each participant was spending around 8-10 minutes/day completing their diary, well within the 20 minutes/day recommended earlier in this paper *(10)*. The evidence seems to suggest that once participants had gone through the first day, completion times were quicker by around 25%, although there is some fluctuation around this.



**1 segment (mean = 97s, median = 57s); 2 segments (mean = 109s, median = 81s); 3+ segments (mean = 123s, median = 94s)*

Figure 5: Time taken to complete the online diary per trip

5. Diary functionality and data quality

The online diary included many features designed to improve the quality and completeness of data, while at the same time keeping participant burden to a minimum. This section assesses the various features of the diary using measures of usage/interaction. The analysis is conducted on the 33 participants who completed the diary from which a total of 852 trips were recorded.

5.1 Trip segments

A key feature of the diary was the drag and drop interface for travel mode designed to capture the different travel segments. This included the prompting of participants for incidental travel to access or egress other modes of travel, something which is often overlooked/forgotten by participants in recall surveys *(17)*. Of the 181 (21%) of trips involving travel by more than one mode, comprising a total of 513 segments, 113 of these trips required access/egress resulting in 237 segments. Of these 113 trips, 35 (30%) required prompting for the access segment (16 times) and the egress segment (24 times). This clearly highlights the importance of the prompting.

5.2 Modify/delete/insert trips

Participants were provided with the capability of checking and correcting their trip information subsequent to final submission for each day. In all, 34 (4%) of trips were inserted, 53 (6%) were

deleted, while 129 (15%) were modified/corrected, suggesting both a relatively high level of diligence and the importance of being able to go back and change information.

5.3 Completeness of trip information

Although the diary was designed to 'force' participants to complete trips, it was possible to provide incomplete trip details if, during the input of trip details, participants clicked on the edit/modify trip function. In total, 817/852 (96%) of trips included full details, with the remaining 35 trips largely attributable to two participants who discovered this loophole and subsequently appeared to employ it on a regular basis. Of these 35 trips, four failed to get past the 'Places' screen (i.e., did not provide origin-destination), while 31 failed to get past the 'Transport' screen (i.e., did not provide mode information).

5.4 Provision of address information

Self-reported address information is generally of mixed quality from travel surveys, because other than home, work, school and possibly one or two other frequently visited locations, participants struggle to recall information to the specificity required. In this diary, participants were required to provide a place name, while street name and suburb were optional. The main feature designed to improve address information was the auto-fill functionality tied to pre-filled databases of commonly-visited locations. In total, 80% of locations were provided with a street name while 98% included the suburb. Overall, 432 unique locations were provided (counted as once per participant), around 13 unique locations/participant, of which 46 (10%) came from the pre-filled database. Unique locations could also have occurred if participants called the same destination by a different name. For example, one person went to 'Leichardt Primary School' and 'Leichardt Public School', which appear to be the same place but would be recognised as 'unique' in the database.

5.5 Favourite trips

The 'Favourite trip' functionality was designed to reduce the time burden of inputting repetitive trips. In all, 56 trips were set as favourite trips with an additional 72 trips based on a favourite trip. These were primarily commuting and returning home trips with the remainder split among a variety of activities. An interesting question is how many trips were repetitive that used (and did not use) the favourite trip function. In all, there were 312 trips from 110 origin-destination pairs (most frequent was 9). Of these, 120 trips (including trips set as favourite) from 34 pairs used a favourite trip. Conversely, 192 trips from 76 pairs did not use favourite trips.

5.6 Time lag for trip completion

Assessing the time lag between when travel was made and when it was recorded in the diary provides insights into diligence and potentially the reliability of data. Three-quarters of trips were recorded within 24 hours of being made and 94% were entered within 48 hours, suggesting a generally high level of diligence. Interestingly, around half of trips were entered on the actual day they were made, again suggesting [perhaps surprisingly] high levels of diligence.

6. GPS versus non-GPS users

A primary rationale for the GPS component was to verify/correct data collected by the diary as has been done in many previous applications *(13) (17)*. As previously discussed, the GPS component of the survey did not work as well as planned in terms of the completeness and quality of data recorded. It therefore proved problematic to use GPS as the bench-mark against which to assess the completeness of the diary, although work is continuing to look at those users who did provide both complete diary and GPS data. An additional rationale for the GPS component was recent evidence suggesting that participants taking a GPS device with them may be more diligent in reporting travel *(13)*. In this study, although the sample size clearly

precludes statistical comparisons, it is never-the-less revealing to assess whether this hypothesis appears to hold true.

For the purposes of this analysis, the sample was differentiated by whether they had taken the GPS with them or not. This resulted in 22 persons being included as GPS users, comprising the 19 with complete data plus three who had spurious data, but had clearly taken it with them. Non-GPS Users included the six diary-only participants plus five who had clearly not taken the device with them. Table 1 compares travel diary information for the two groups. While the small sample sizes preclude statistical comparisons, the GPS users evidently reported more trips/day and segments/day, fewer missing days, and have higher trip completion rates, although they appear to be slightly less diligent in terms of when they made the trip and recorded it in the diary. This suggests that, irrespective of being able to view previous travel, the act of carrying a GPS device may have some benefits for data collection.

Table 1: Comparison of travel diary information by GPS and non-GPS users

	GPS Users	Non-GPS Users	Total Sample
Total Participants	22	11	33
Total Travel Days	154	77	231
No Travel Days - Diary	8 (5.2%)	5 (6.5%)	13 (5.6%)
Total Trips	585	267	852
Average Trip rates/day	3.80	3.47	3.69
Total Segments	819	332	1151
Average Segments/day	5.32	4.31	4.98
Trip Completion	566 (97%)	251 (94%)	817 (96%)
Time lag for trip completion (median)	11 hours, 54 mins	11 hours, 27 mins	11 hours, 48 mins

7. Conclusions

This paper details the development of a new online travel/activity diary to support a major longitudinal investigation of travel in Sydney. The diary employs several unique features designed to simplify the process of data entry, and improve participant recall and completeness of travel, including auto-fills, prompts, trip editing capabilities, favourite trips, and a drag-and-drop technique for capturing travel mode information. An additional innovation is the ability to view a GPS-based Google map of daily travel while completing the diary to assist with recall, without needing to wait until after the study period to complete the diary. The diary was tested on 37 participants, with a range of diagnostics provided to assess their reaction, usage, burden, and completeness of data provided. Overall, results were highly encouraging with 89% of participants completing all seven days of data collection and 96% of trips provided with complete details. 90% of participants indicated they would be willing to do the survey again if asked, testament to usability. Evidently, the use of daily reminders was crucial in encouraging timely completions and importantly, the task was kept relatively low-burden with trip entry times averaging around two minutes per trip. In terms of the GPS component, while the optional viewing of trips was lower than anticipated, those carrying a GPS reported more trips/day and segments/day, fewer missing days, and had higher rates of trip completion, which is in line with previous evidence *(13)*.

Although the diary generally worked well, several enhancements are currently being implemented based on the outcomes of this pilot study. First, several cosmetic changes are being made including adaptation of displays to work better on tablets and smartphones. Second, trip durations were not well reported so this information is now being collected in terms of arrival and departure times and individual segment durations (in minutes) Participants are also

now shown a progress bar, to let them know at what stage in the process they are, and what they will be asked next. Additions and clarifications to field names and descriptions are also being added to reduce ambiguities. Third, the GPS component of the survey did not work as well as planned, with many of the devices returned with missing or spurious data, something attributable to the reliance on people to keep the device charged and with them, device malfunction, and signal quality problems associated with using GPS in what was a heavily built-up area. Compounding these problems for the optional GPS-viewing component were additional barriers associated with having to download the utility and plug the device in before completing the diary. A potential alternative to this is to develop an app, which performs a similar tracking function, that can be downloaded and installed on a participant's smartphone with data uploaded to a web-based interface *(20, 24–26)*. The main rationale here is that a participant's own phone is something they are more likely to keep charged and take with them *(20)*. However, several challenges remain here related to the practicalities of battery drain and ethical issues associated with using a participant's device as opposed to providing them with one.

In terms of wider implications for the travel data collection community, while there has been negativity towards travel diaries in recent years, it is the authors' opinion that the online environment provides an opportunity for re-invention. This opinion is driven by the capabilities offered to overcome many of the perceived deficiencies of traditional diaries, integration with new data collection technologies to make the process more engaging, and access to an increasing number of people that are increasingly difficult to reach by post and telephone. In addition, web technology allows researchers to gain a better understanding of how, when and where participants complete travel diaries, enhancing the ability to improve the quality of the diaries and thereby increase the quality of data collected.

References

1. Stopher, P. R., and S. P. Greaves. Household travel surveys: Where are we going? *Transportation Research Part A: Policy and Practice*, Vol. 41, No. 5, Jun. 2007, pp. 367–381.

2. Transport Data Centre. *2007 Household Travel Survey: 2009 Release. Summary Report*. Sydney, 2009.

3. Elango, V. V., R. Guensler, and J. Ogle. Day-to-Day Travel Variability in the Commute Atlanta, Georgia, Study. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2014, No. 2014, 2007, pp. 39–49.

4. Hensher, D. A., and A. J. Reyes. Trip chaining as a barrier to the propensity to use public transport. *Transportation*, Vol. 27, No. 4, 2000, pp. 341–361.

5. Hess, D. B. Effect of free parking on commuter mode choice: Evidence from travel diary data. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1753, 2001, pp. 35–42.

6. Dijst, M., T. de Jong, and J. R. van Eck. Opportunities for transport mode change: an exploration of a disaggregated approach. *Environment and Planning B*, Vol. 29, No. 3, 2002, pp. 413–430.

7. Ampt, E. S. Quality and Cost-effectiveness in Recording a 24-hour Travel Diary. *Proceedings of the 17th Australasian Transport Research Forum*, Canberra, 1992.

8. Polak, J., J. Plaxton, P. G. Jackson, and D. Wofinden. Using the Internet To Improve Long-Distance Travel Data Collection. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1660, 1999, pp. 148–155.

9. Adler, T., L. Rimmer, and D. Carpenter. Use of Internet-Based Household Travel Diary Survey Instrument. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1804, 2002, pp. 134–143.

10. Kenyon, S. The "accessibility diary": Discussing a new methodological approach to understand the impact of Internet use upon personal travel and activity participation. *Journal of Transport Geography*, Vol. 14, No. 2, Mar. 2006, pp. 123–134.

11. Theriault, M., M. Lee-Gosselin, F. Theberge, and L. Dieumegarde. Web versus pencil-and-paper surveys of weekly mobility: conviviality, technical and privacy issues. In *Transport survey methods: best practice for decision making* (J. Zmud, M. Lee-Gosselin, M. Munizaga, and J.-A. Carrasco, eds.), Emerald Group Pub Limited, Bingley, UK, pp. 225–246.

12. Richardson, A. J., E. S. Ampt, and A. H. Meyburg. *Survey methods for transport planning*. Eucalyptus Press Australia, 1995.

13. Stopher, P., and S. Greaves. Missing and inaccurate information from travel surveys: pilot results. *Proceedings of the 32nd Australian Transport Research Forum*, Auckland, New Zealand, 2010.

14. Zmud, J., M. Lee-Gosselin, M. Munizaga, and J.-A. Carrasco. Transport surveys: considerations for decision makers and decision making. In *Transport survey methods: best practice for decision making* (J. Zmud, M. Lee-Gosselin, M. Munizaga, and J.-A. Carrasco, eds.), Emerald, Bingley, UK, pp. 3–19.

15. Bourbonnais, P.-L., and C. Moreney. Web-based travel surveys. In *Transport survey methods: best practice for decision making* (J. Zmud, M. Lee-Gosselin, M. Munizaga, and J.-A. Carrasco, eds.), Emerald, Bingley, UK, pp. 207–223.

16. Ali, A., and S. Lui. Household Trip Patterns and Travel Characteristics in Lethbridge, Alberta. *Annual Conference of the Transportation Association of Canada*, Edmonton, Alberta, Canada, 2011.

17. Clifton, K., and C. D. Muhs. Capturing and Representing Multimodal Trips in Travel Surveys. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2285, Dec. 2012, pp. 74–83.

18. Son, S., A. Khattak, X. Wang, and J.-Y. Chen. Transferring Telephone-Based National Household Travel Survey to the Internet. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2285, No. -1, Dec. 2012, pp. 91–99.

19. Clark, A., and D. Scott. Does the social environment influence active travel? An investigation of walking in Hamilton, Canada. *Journal of Transport Geography*, 2013.

20. Cottrill, C. D., F. C. Pereira, F. Zhao, I. F. Dias, H. B. Lim, M. E. Ben-Akiva, and P. C. Zegras. The Future Mobility Survey: Experiences in developing a smartphone-based travel survey in Singapore. *Annual Meeting of the Transportation Research Board*, Washington, D.C., 2013.

21. Greaves, S., S. Fifer, R. Ellison, and G. Germanos. Development of a Global Positioning System web-based prompted recall solution for longitudinal travel surveys. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2183, Dec. 2010, pp. 69–77.

22. Experian. *Experian Marketing Services' 2013 Q1 email benchmark study*. 2013.

23. Richardson, A. J., and A. H. Meyburg. Definitions of Unit Non-Response in Travel Surveys. *International Conference on Transport Survey Quality*, Kruger National Park, South Africa, 2001.

24. Hudson, J. G., J. C. Duthie, Y. K. Rathod, K. A. Larsen, and J. L. Meyer. *Using Smartphones to Collect Bicycle Travel Data in Texas*. College Station, Texas, 2012.

25. Fan, Y., Q. Chen, C.-F. Liao, and F. Douma. UbiActive : A Smartphone-Based Tool for Trip Detection and Travel-Related Physical Activity Assessment. *Annual Meeting of the Transportation Research Board*, Washington, D.C., 2013.

26. Abdulazim, T., H. Abdelgawad, K. M. N. Habib, and B. Abdulhai. Using Smartphones and Sensor Technologies to Automate the Collection of Travel Data. *Annual Meeting of the Transportation Research Board*, Washington, D.C., 2013.